Enhancing Finger Vein Recognition With Feature Frequency Decoupling

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Finger vein recognition is an emerging biometric technology offering secure and reliable personal identification, particularly valuable in digital financial transactions. However, current approaches face limitations such as inconsistent accuracy under varied image conditions and trade-offs between computational efficiency and recognition performance. This project developed an innovative, lightweight finger vein recognition model named Spatial Feature Attention model based on Feature Decoupling (SFA-FD), with two modules proposed: The Wavelet Feature Decoupling Module (WFDM) employs wavelet transforms to extract both vein textures (high-frequency details) and background information (low-frequency features), and adaptively recombining these features to enhance recognition accuracy. The Spatial Feature Attention Module (SFAM) captures global patterns and detailed local features, balancing the advantages of CNN-based and transformer-based methods and enhancing the model's robustness. Rigorous testing was conducted across seven diverse public datasets, covering realistic conditions such as different image quality, lighting, demographics, and dataset size. Ablation studies examine the effective design of WFDM and SFAM and their essential contributions to the model, showing the value of previously neglected background information and texture-based models' shortcomings. Results indicated that the proposed model has better outcomes than the existing state-of-the-art models across seven diverse datasets, achieving higher accuracy while reducing computational requirement (only 2.45 million parameters and 0.78 GFLOPs). This balance of high performance and efficiency positions the model for broad practical application in banking, healthcare, and national security systems.

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